THE RELATION OF PHOTOPERIOD AND TEMPERATURE TO FOOD AND WATER CONSUMPTION, VARIATIONS IN WEIGHT, AND MOLT IN BIRDS

BY

HENRI CLERET SEIBERT

B.S., Haverford College, 1937
M.Sc., Johns Hopkins University, 1940

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN
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THE UNIVERSITY OF ILLINOIS, 1947

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THE RELATION OF PHOTOPERIOD AND TEMPERATURE TO FOOD AND WATER CONSUMPTION, VARIATIONS IN WEIGHT, AND MOLT IN BIRDS

Birds undergo seasonal rhythms in the maturation of the gonads, raising of offspring, migration, and molt. These activities require energy and energy is obtained only by consuming food. For practically all birds, except owls, feeding is done only during the daylight hours when enough food must be ingested to last overnight. It therefore becomes important to determine the role that the photoperiod plays on the amount of food consumed. Since the energy balance of the body is affected by the temperature to which it is subjected, it becomes necessary to combine external temperature with photoperiod. Knowing under what conditions the bird is able to gain, lose, or merely maintain itself in its energy balance should supply a clue as to why these rhythmicities in the bird's life occur when they do.

The birds were trapped from wild populations and placed in large cages illuminated with 150-watt bulbs. The total light given the birds was increased by short increments, maintained at a constant level for approximately a month, then reduced at a rate similar to the increase. Additional species of birds, not previously reported, were made to molt two to four months ahead of their usual autumn molting period by artificially reducing the photoperiod. These were the cardinal, junco, screech owl, song sparrow, and blue jay. The screech owl responded with a full molt in spite of its being a nocturnal species. Molt, once in progression, was not inhibited by reversed changes in photoperiod. Verification was obtained that the onset of molt was hastened by an increase in the rate at which the photoperiod was reduced.

Birds were placed in individual cages and the amount of energy consumed was determined for different temperatures at both 10- and 15-hour photoperiods. Weighed amounts of food were given each bird and the food was withdrawn four to five days later. The feces were extracted and the total dry

weight of food consumed determined. All results were calculated in terms of calories per hour of actual feeding time; the calories per hour times the total hours in the photoperiod gave the rate per day. The gross energy consumed per day by the junco, white-throated sparrow, and English sparrow, increased with a drop in temperature, but not at the same rate in all species. The gross energy consumed per hour was greater on the 10-hour photoperiod than on the 15, but the increase was usually not sufficient to make the total energy consumed for the entire day greater during the 10 hours than during the 15. The blue jay at 22° and the English sparrow at —13° were exceptions by being able to consume as much during the short day as the long day. The energy lost per gram of dry feces was greatest at 34° in all three species and least at 22°. The energy lost in the feces per day decreased with a rise in temperature up to 22°, then increased again at 34° in the junco and in the white-throat on a 15-hour photoperiod. The daily loss in energy by the English sparrow at both photoperiods and by the white-throat on a 10-hour photoperiod continued to increase up to 34°. The metabolizable energy, i.e., the energy consumed minus the energy lost in the feces, absorbed by the junco, white-throat, and English sparrow increased with a drop in temperature at both a 10- and 15-hour photoperiod. The rate of increase in the junco was practically a linear function of the temperature at both photoperiods. In the white-throat the rate of increase on a 10-hour photoperiod declined sharply at low temperatures. On the 15-hour photoperiod the rate showed only a slight deceleration at low temperatures. In the English sparrow the rate increased on the 10-hour photoperiod with decrease in temperature much more than on a 15-hour photoperiod.

The daily rate of food absorption increased per unit of weight with a decrease in the size of the bird. The food consumption and absorption relative to body surface was variable but tended to fluctuate around a mean. The field sparrow ate considerably more than the other species when comparisons were made at 22° on the basis of either weight or surface area. Individual birds responded to changes in temperature and photoperiod in a manner similar to their group averages.

Water consumption by the English sparrow was balanced by the amount lost through the lungs and feces. Water consumption increased with a rise in temperature in the English sparrow, junco, and white-throat. It was greatest in the white-throat and least in the junco.

The time of daily maximum weight attainment in the English sparrow and white-throat was caused to shift to a later hour by an increase in the length of the photoperiod. The weight lost during the night was greatest during the first part of the dark period, decelerating until morning. The per cent weight lost overnight by the English sparrow decreased when the photoperiod was increased. The per cent weight loss overnight by the white-throat and the English sparrow was greater at 34° than at 22°. In the junco the loss was greater at 22°.

It was concluded that molt is adjusted to late summer when the photoperiod is long enough to enable the bird to consume enough food to satisfy the energy demands of the molting process and when other energy demands on the bird are at a minimum.

The junco and the white-throat migrate south in the fall because the decreasing photoperiod and the colder temperatures do not enable the birds to obtain sufficient food to meet their energy requirements. The same species migrate north in the spring because the warmer temperatures disturb the temperature regulation and reduce food absorption. This is especially true in the white-throat whose water loss greatly increases with a rise in temperature. The English sparrow is not forced to migrate because cold temperatures at a short photoperiod induce a faster rate of energy absorption than in the two migrant species. Warm temperatures at long photoperiods do not reduce its energy absorption to the same extent as it does migrant species. The blue jay, another non-migrant, appears to respond similarly to the English sparrow. The field sparrow may be limited in its northward migration by its extremely high food requirements.

VITA

Henri Cleret Seibert was born at Caen, France, July 20, 1915. He attended public school in France for one year, then came to the United States in 1921. In this country he attended the public grammar and high schools of Baltimore, Maryland, and was graduated in 1933. From 1933 to 1937 he was a student at Haverford College and graduated with Honors in biology and a B.S. degree in 1937. He studied under the late Raymond Pearl at the Johns Hopkins University and received his M.Sc. degree in 1940. From 1933 to 1941 he was Associate Curator of Birds and Mammals of the Natural History Society of Maryland.

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